Frequently Asked Questions

FAQ

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These Frequently Asked Questions have been extracted from the chapters of the underlying report and are compiled here. When referencing specific FAQs, please reference the corresponding chapter in the report from where the FAQ originated (e.g., FAQ 3.1 is part of Chapter 3).

Frequently Asked Questions

FAQ 4.1 | How Will the Climate Change Over the Next Twenty Years?

The parts of the climate system that have shown clear increasing or decreasing trends in recent decades will continue these trends for at least the next twenty years. Examples include changes in global surface temperature, Arctic sea ice cover, and global average sea level. However, over a period as short as twenty years, these trends are substantially influenced by natural climate variability, which can either amplify or attenuate the trend expected from the further increase in greenhouse gas concentrations.

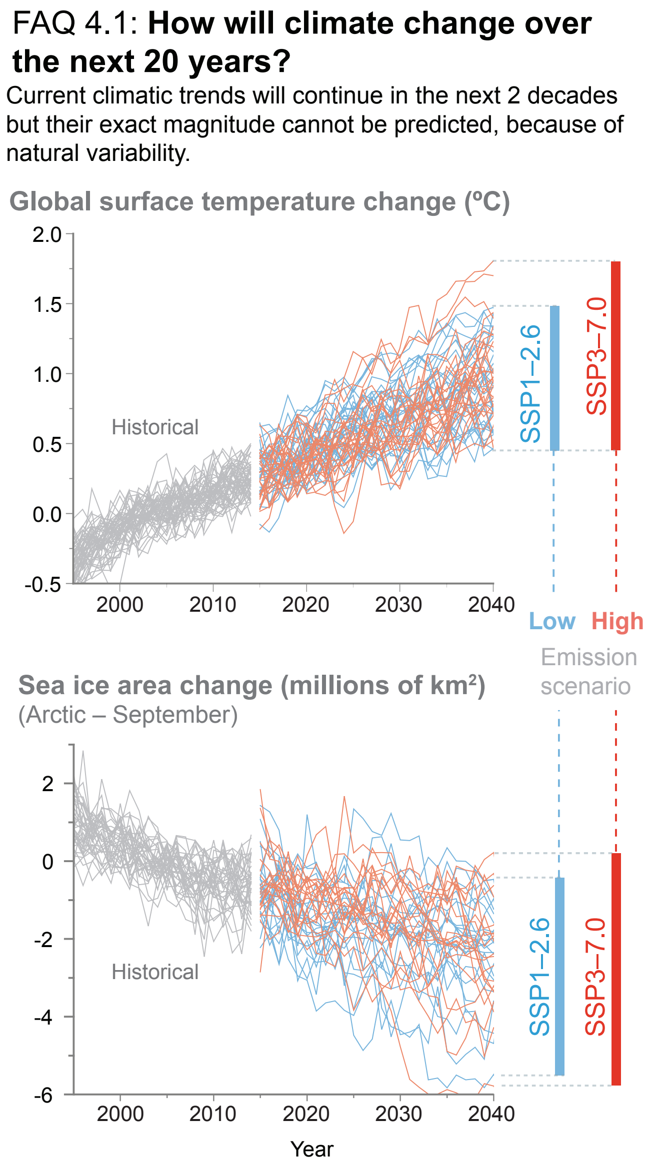
Twenty years are a long time by human standards but a short time from a climate point of view. Emissions of greenhouse gases will continue over the next twenty years, as assumed in all the scenarios considered in this Report, albeit with varying rates. These emissions will further increase concentrations of greenhouse gases in the atmosphere (see FAQ 4.2), leading to continued trends in global surface warming and other parts of the climate system, including Arctic sea ice and global average sea level (see FAQ 9.2). FAQ 4.1, Figure 1 shows that both global surface temperature rise and the shrinking of sea ice in the Arctic will continue, with little difference between high- and low-emissions scenarios over the next 20 years (that is, between the red and blue lines).

However, these expected trends will be overlain by natural climate variability (see FAQ 3.2). First, a major volcanic eruption might occur, such as the 1991 eruption of Mt. Pinatubo on the Philippines; such an eruption might cause a global surface cooling of a few tenths of a degree Celsius lasting several years. Second, both atmosphere and ocean show variations that occur spontaneously, without any external influence. These variations range from localized weather systems to continent- and ocean-wide patterns and oscillations that change over months, years, or decades. Over a period of twenty years, natural climate variability strongly influences many climate quantities, when compared to the response to the increase in greenhouse gas concentrations from human activities. The effect of natural variability is illustrated by the very different trajectories that individual black, red or blue lines can take in FAQ 4.1, Figure 1. Whether natural variability would amplify or attenuate the human influence cannot generally be predicted out to twenty years into the future. Natural climate variability over the next twenty years thus constitutes an uncertainty that at best can be quantified accurately but that cannot be reduced.

Locally, the effect of natural variability would be much larger still. Simulations (not shown here) indicate that, locally, a cooling trend over the next twenty years cannot be ruled out, even under the high-emissions scenario – at a small number of locations on Earth, but these might lie anywhere. Globally, though, temperatures would rise under all scenarios.

In summary, while the direction of future change is clear for the two important climate quantities shown here – the global surface temperature and the Arctic sea ice area in September – the magnitude of the change is much less clear because of natural variability.

FAQ 4.1 (continued)



FAQ 4.1: **How will climate change over the next 20 years?**

Current climatic trends will continue in the next 2 decades but their exact magnitude cannot be predicted, because of natural variability.

FAQ 4.1, Figure 1 | Simulations over the period 1995–2040, encompassing the recent past and the next twenty years, of two important indicators of global climate change. (Top) Global surface temperature, and **(bottom)**, the area of Arctic sea ice in September. Both quantities are shown as deviations from the average over the period 1995–2014. The grey curves are for the historical period ending in 2014; the blue curves represent a low-emissions scenario (SSP1-2.6) and the red curves one high-emissions scenario (SSP3-7.0).

Frequently Asked Questions

FAQ 4.2 | How Quickly Would We See the Effects of Reducing Carbon Dioxide Emissions?

The effects of substantial reductions in carbon dioxide emissions would not be apparent immediately, and the time required to detect the effects would depend on the scale and pace of emissions reductions. Under the lower-emissions scenarios considered in this Report, the increase in atmospheric carbon dioxide concentrations would slow visibly after about five to ten years, while the slowing down of global surface warming would be detectable after about twenty to thirty years. The effects on regional precipitation trends would only become apparent after several decades.

Reducing emissions of carbon dioxide (CO_2) – the most important greenhouse gas emitted by human activities – would slow down the rate of increase in atmospheric CO_2 concentration. However, concentrations would only begin to decrease when net emissions approach zero, that is, when most or all of the CO_2 emitted into the atmosphere each year is removed by natural and human processes (see FAQ 5.1 and FAQ 5.3). This delay between a peak in emissions and a decrease in concentration is a manifestation of the very long lifetime of CO_2 in the atmosphere; part of the CO_2 emitted by humans remains in the atmosphere for centuries to millennia.

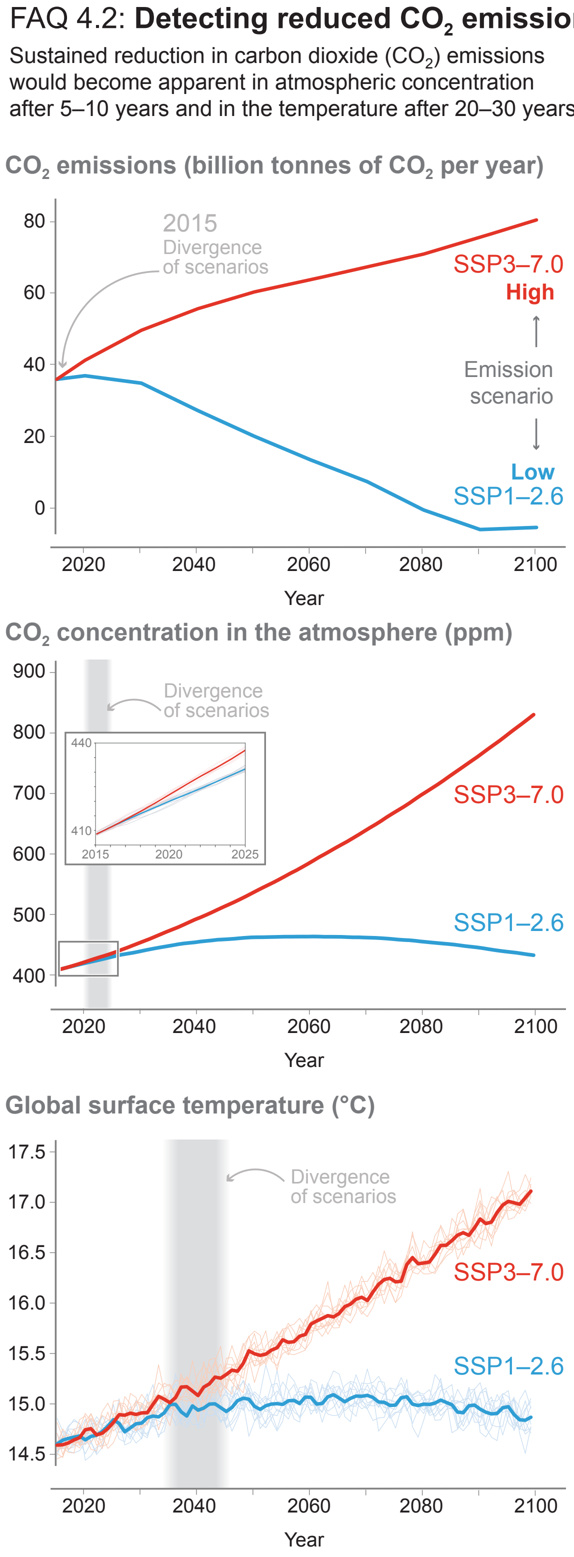
Reducing the rate of increase in CO_2 concentration would slow down global surface warming within a decade. But this reduction in the rate of warming would initially be masked by natural climate variability and might not be detected for a few decades (see FAQ 1.2, FAQ 3.2 and FAQ 4.1). Detecting whether surface warming has indeed slowed down would thus be difficult in the years right after emissions reductions begin.

The time needed to detect the effect of emissions reductions is illustrated by comparing low- and high-emissions scenarios (FAQ 4.2, Figure 1). In the low-emissions scenario (SSP1-2.6), CO_2 emissions level off after 2015 and begin to fall in 2020, while they keep increasing throughout the 21st century in the high-emissions scenario (SSP3-7.0). The uncertainty arising from natural internal variability in the climate system is represented by simulating each scenario ten times with the same climate model but starting from slightly different initial states back in 1850 (thin lines). For each scenario, the differences between individual simulations are caused entirely by simulated natural internal variability. The average of all simulations represents the climate response expected for a given scenario. The climate history that would actually unfold under each scenario would consist of this expected response combined with the contribution from natural internal variability and the contribution from potential future volcanic eruptions (the latter effect is not represented here).

FAQ 4.2, Figure 1 shows that the atmospheric CO_2 concentrations differ noticeably between the two scenarios about five to ten years after the emissions have begun to diverge in year 2015. In contrast, the difference in global surface temperatures between the two scenarios does not become apparent until later – about two to three decades after the emissions histories have begun to diverge in this example. This time would be longer if emissions were reduced more slowly than in the low-emissions scenario illustrated here and shorter in the case of stronger reductions. Detection would take longer for regional quantities and for precipitation changes, which vary more strongly from natural causes. For instance, even in the low-emissions scenario, the effect of reduced CO_2 emissions would not become visible in regional precipitation until late in the 21st century.

In summary, it is only after a few decades of reducing CO_2 emissions that we would clearly see global temperatures starting to stabilize. By contrast, short-term reductions in CO_2 emissions, such as during the COVID-19 pandemic, do not have detectable effects on either CO_2 concentration or global temperature. Only sustained emissions reductions over decades would have a widespread effect across the climate system.

FAQ 4.2 (continued)



FAQ 4.2, Figure 1 | Observing the benefits of emissions reductions. (Top) Carbon dioxide (CO$_2$) emissions, **(middle)** CO$_2$ concentration in the atmosphere and **(bottom)** effect on global surface temperature for two scenarios: a low-emissions scenario (SSP1-2.6, blue) and a high-emissions scenario (SSP3-7.0). In the low-emissions scenario, CO$_2$ emissions begin to decrease in 2020 whereas they keep increasing throughout the 21st century in the high-emissions scenario. The thick lines are the average of the 10 individual simulations (thin line) for each scenario. Differences between individual simulations reflect natural variability.

Frequently Asked Questions

FAQ 4.3 | At a Given Level of Global Warming, What Are the Spatial Patterns of Climate Change?

As the planet warms, climate change does not unfold uniformly across the globe, but some patterns of regional change show clear, direct and consistent relationships to increases in global surface temperature. The Arctic warms more than other regions, land areas warm more than the ocean surface, and the Northern Hemisphere more than the Southern Hemisphere. Precipitation increases over high latitudes, tropics and large parts of the monsoon regions, but decreases over the subtropics. For cases like these, we can infer the direction and magnitude of some regional changes – particularly temperature and precipitation changes – for any given level of global warming.

The intensity of climate change will depend on the level of global warming. It is possible to identify certain patterns of regional climate change that occur consistently, but increase in amplitude, across increasing levels of global warming. Such robust spatial patterns of climate change are largely independent of the specific scenario (and pathway in time) that results in a given level of global warming. That is, as long as different scenarios result in the same global warming level, irrespective of the time when this level is attained in each scenario, we can infer the patterns of regional change that would result from this warming. When patterns of changes are robust, regional consequences can be assessed for all levels of global warming, for all future time periods, and for all scenarios. Temperature and precipitation show such robust patterns of changes that are particularly striking.

The high latitudes of the Northern Hemisphere are projected to warm the most, by two to four times the level of global warming – a phenomenon referred to as Arctic amplification (FAQ 4.3, Figure 1, left). Several processes contribute to this high rate of warming, including increases in the absorption of solar radiation due to the loss of reflective sea ice and snow in a warmer world. In the Southern Hemisphere, Antarctica is projected to warm faster than the mid-latitude Southern Ocean, but the Southern Hemisphere high latitudes are projected to warm at a reduced amplitude compared to the level of global warming (FAQ 4.3, Figure 1, left). An important reason for the relatively slower warming of the Southern Hemisphere high latitudes is the upwelling of Antarctic deep waters that drives a large surface heat uptake in the Southern Ocean.

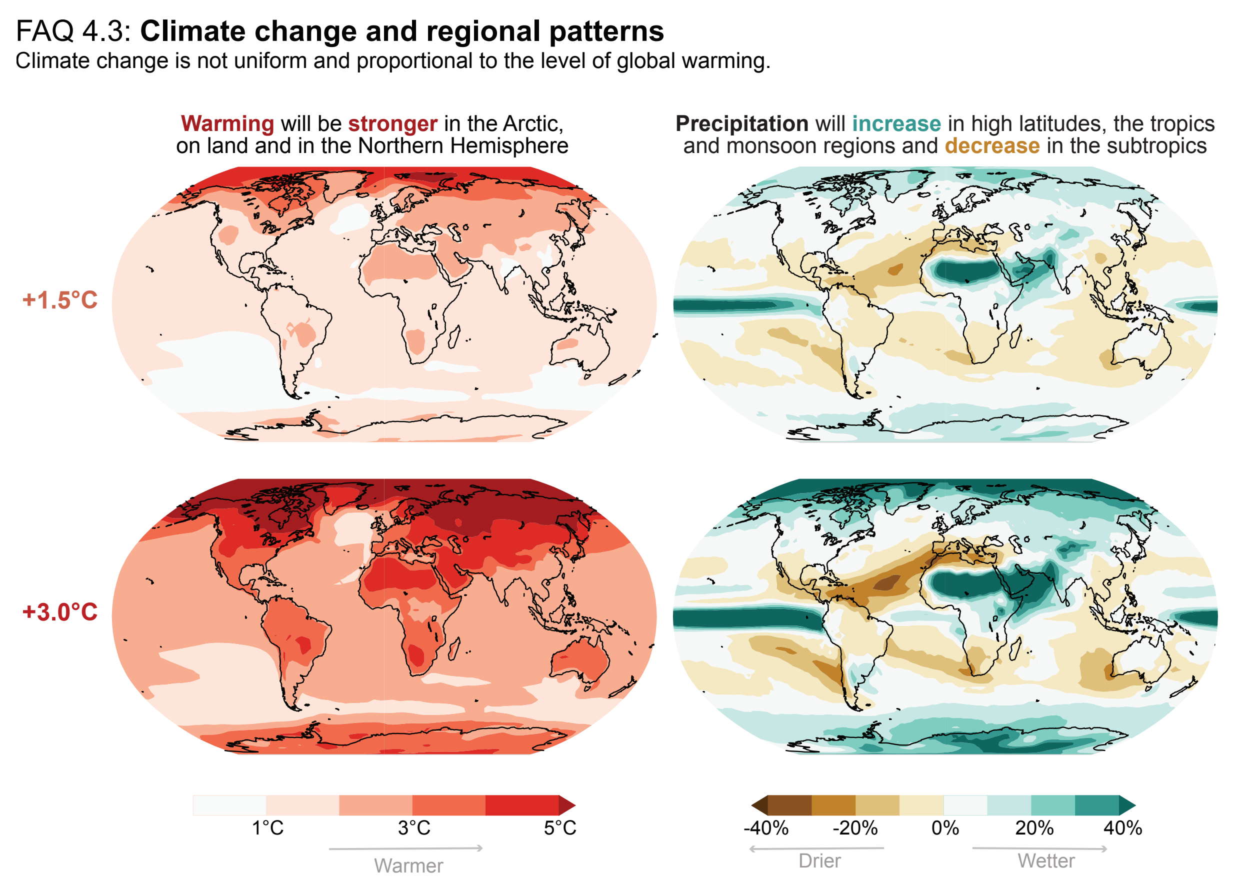
The warming is generally stronger over land than over the ocean, and in the Northern Hemisphere compared to the Southern Hemisphere, and with less warming over the central subpolar North Atlantic and the southernmost Pacific. The differences are the result of several factors, including differences in how land and ocean areas absorb and retain heat, the fact that there is more land area in the Northern Hemisphere than in the Southern Hemisphere, and the influence of ocean circulation. In the Southern Hemisphere, robust patterns of relatively high warming are projected for subtropical South America, southern Africa, and Australia. The relatively strong warming in subtropical southern Africa arises from strong interactions between soil moisture and temperature and from increased solar radiation as a consequence of enhanced subsidence.

Precipitation changes are also proportional to the level of global warming (FAQ 4.3, Figure 1, right), although uncertainties are larger than for the temperature change. In the high latitudes of both the Southern and Northern Hemispheres, increases in precipitation are expected as the planet continues to warm, with larger changes expected at higher levels of global warming (FAQ 4.3, Figure 1, right). The same holds true for the projected precipitation increases over the tropics and large parts of the monsoon regions. General drying is expected over the subtropical regions, particularly over the Mediterranean, southern Africa and parts of Australia, South America, and south-west North America, as well as over the subtropical Atlantic and parts of the subtropical Indian and Pacific Oceans. Increases in precipitation over the tropics and decreases over the subtropics amplify with higher levels of global warming.

Some regions that are already dry and warm, such as southern Africa and the Mediterranean, are expected to become progressively drier and drastically warmer at higher levels of global warming.

In summary, climate change will not affect all the parts of the globe evenly. Rather, distinct regional patterns of temperature and precipitation change can be identified, and these changes are projected to amplify as the level of global warming increases.

FAQ 4.3 (continued)



FAQ 4.3: **Climate change and regional patterns**

Climate change is not uniform and proportional to the level of global warming.

FAQ 4.3, Figure 1 | Regional changes in temperature (left) and precipitation (right) are proportional to the level of global warming, irrespective of the scenario through which the level of global warming is reached. Surface warming and precipitation change are shown relative to the 1850–1900 climate, and for time periods over which the globally averaged surface warming is 1.5°C **(top)** and 3°C **(bottom)**, respectively. Changes presented here are based on 31 CMIP6 models using the high-emissions scenario SSP3-7.0.